Space Weather Technical Forecast

Issued on Saturday, 20 April 2024 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-flares likely and a slight chance of X-flares. Slight chance of G1/Minor Geomagnetic Storms, mainly Days 2-3 (21-22 Apr) due to possible glancing CMEs.

Solar Activity: Moderate, with one M-flare observed, peaking M1.0 at 19/1306 UTC from AR3637 in the south centre disc. There are currently thirteen sunspot containing active regions, however the main activity has been from the southern central disc complex consisting of a number of these regions. Slow growth has been evident in both AR3645 and AR3647, along with a mixed polarity environment, while the easternmost region AR3643 continues to show some decay. Growth is also evident in the re-emergence of AR3637 and AR3638 to the southwest of this region, and AR3650 to the east of it. Across the rest of the disc, minor growth and decay has been observed, however the majority of regions remains small and simple. The exception being AR3639 in the north-centre, which is moderately sized, but also of a simple bipolar configuration.

No clear Earth-directed CMEs have been observed, however a couple of eruption from the south of AR3647/AR3643 were observed and assessed as likely either missing, or giving very weak glancing impacts at most. A CME was also identified from the M1.0 flare of AR3637, however this was faint with limited imagery and was hard to isolate from other not Earth-directed CMEs. Consequently analysis is still on going.

Solar Wind / Geomagnetic Activity: The solar wind showed ongoing CME influence, which arrived around 0452 UTC on 19 Apr, along with the onset of the fast wind of CH25/-. Speeds observed by ACE at L1 increased from 400 km/s to peak 480-520 km/s from 19/2100-20/0600 UTC, before easing back to around 450km/s. Density was around average, peaking above average 19/1730 UTC, before gradually easing to be below average by the end of the period. Interplanetary Magnetic Field (IMF), Bt, was Strong at first, peaking 17nT, but erratically eased to be weak, below 6nT from 20/0000 UTC. The north-south component (Bz) was Strong negative (southward) at first with minimum -17nT, but slowly rotated to be weakly positive (northward) from 20/2100 UTC, peaking +7nT. This gradually rotated back to weak negative values (-5nT) after 20/0600 UTC. Phi Angle became predominately negative (towards the Sun) from 19/1830 UTC, but has seen some variation since 20/0530 UTC. Geomagnetic activity saw a G1 Minor Storm 19/1200-1800 UTC and G3 Strong storm 19/1800-2100UTC, though the latter was originally reported at G2 (Kp5-7). Activity subsequently eased to Quiet to Active from 19/2100 UTC (Kp2-4).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES-18 was at background. High energy electron flux (greater than 2MeV) observed at GOES-16 was at Background, occasionally reaching Moderate. The associated 24-hour fluence remained below Active (1e8 integrated flux) with a value of 1.02e6 integrated pfu observed at 20/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is forecast with isolated M-class flares expected throughout and a slight chance of isolated X-class flares.

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Solar Wind / Geomagnetic Activity: There are a number of CMEs expected to pass near Earth, originating from the southeast disc between 18-19 Apr, with the potential for weak glancing impacts on Days 2-3 (21-22 Apr). Otherwise ongoing fast wind influence from CH25/- is expected to gradually and erratically ease through this period. Geomagnetic activity is expected to be Quiet with Unsettled intervals for much of the period, however any additional enhancement from CME arrivals will bring the potential for Active to G1 Minor Storm intervals, perhaps most likely later on day 2 or day 3 (21-22 Apr).

Energetic Particles / Solar Radiation: High energy proton flux as observed by GOES-18 is forecasted to persist at background, but with a slight chance of increasing towards the S1 level due to the number of sunspot regions moving into the western hemisphere and any flares they may produce. High energy electron flux as observed by GOES-16 is expected to rise to Moderate, perhaps High levels day 2-3, however this may be limited by any glancing CME impacts that occur. The associated 24hr electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold but with an increasing trend, and a slight chance of reaching Active by days 3-4 (22-23 Apr) depending on the CME influence.

Figure 1a. BGS Geomagnetic Activity.

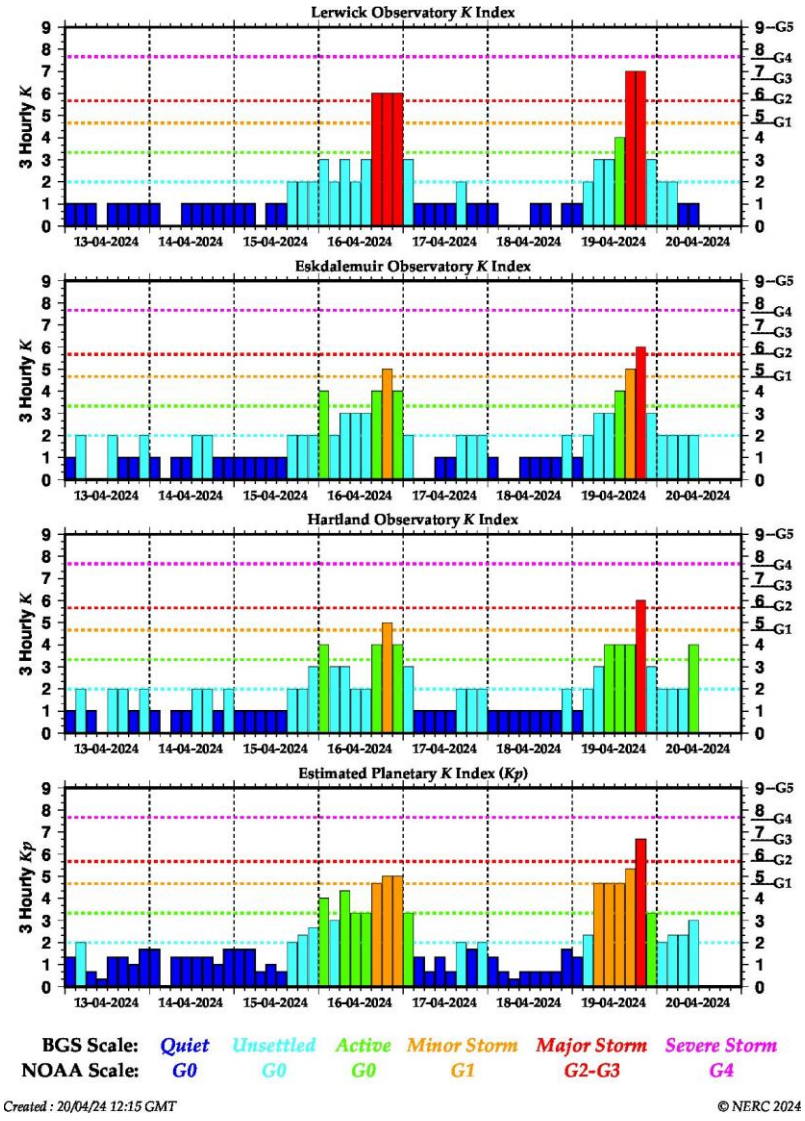

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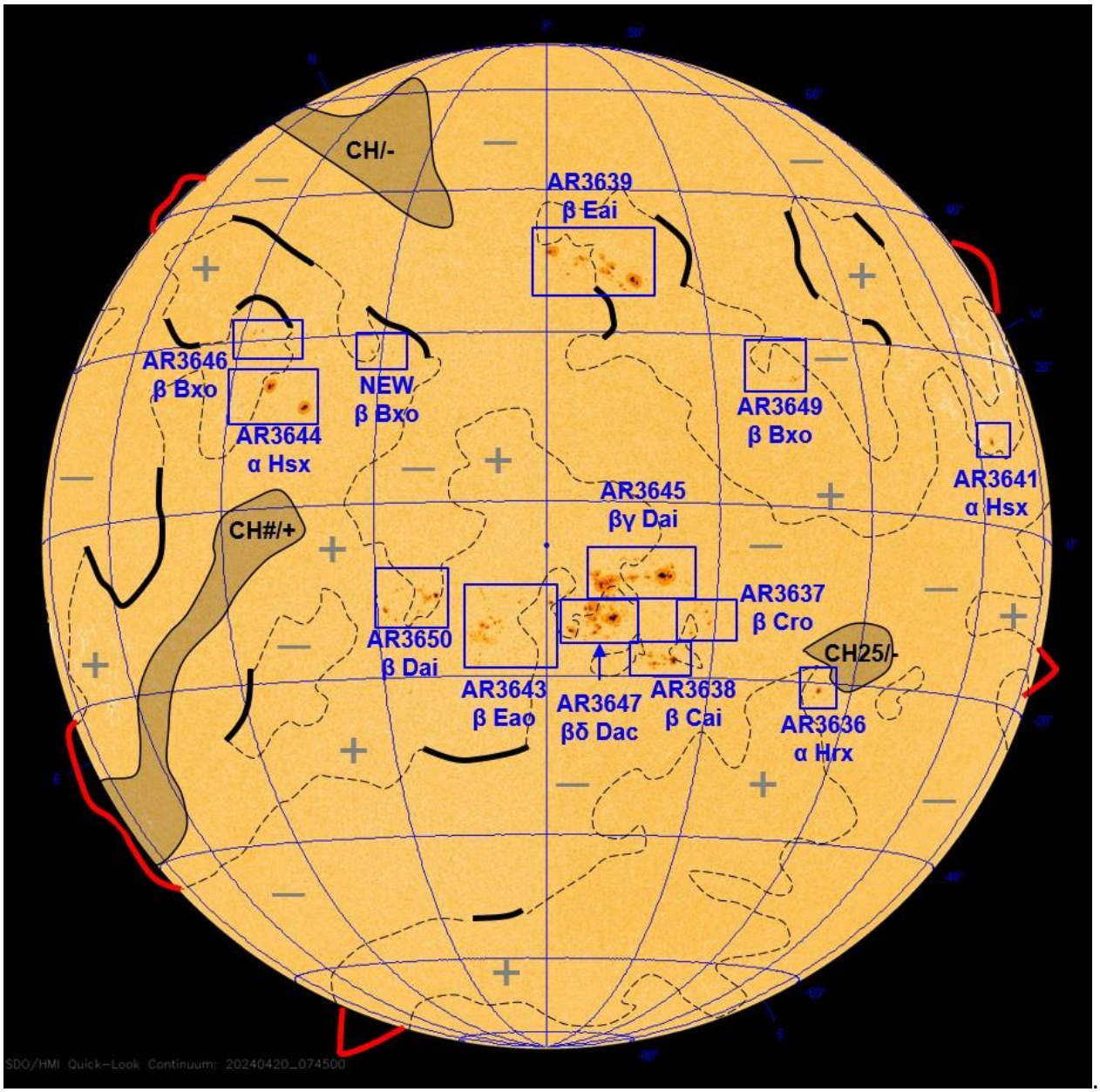
Figure 1b. Solar Analysis Valid 20/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are a number of CMEs that have been observed from around AR3638 during 18 and 19 Apr. These bring the potential for weak glancing impacts through Days 2-3 (21-22 Apr), however confidence is low with the extent of any interaction as the CMEs were faint and generally slow. A further CME has potentially been identified from the M1.0 flare of AR3637 on 19 Apr. This is also very faint, with limited imagery and a number of coincident non-Earth directed CMEs providing additional challenge to identify the CME. Subsequently this is still under analysis and very low confidence, but also has the potential to arrive during this period.

Otherwise, current slightly elevated winds are likely due to a combined influence of the CME arrival on 19 Apr, along with a coincident onset of the fast wind of CH25/-. This is only a small feature, with the current fast winds likely to gradually and erratically ease to background slow wind conditions through Days 2-3 (21-22 Apr). Any CME arrivals may prolong the enhanced solar wind environment however.

Geomagnetic activity is expected to be Quiet with Unsettled intervals for much of the period, however any additional enhancement from CME arrivals will bring the potential for Active to G1 Minor Storm intervals, perhaps most likely later on day 2 or day 3 (21-22 Apr).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	10	20	20	5
Strong	G3	Yes	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
18/1304	None	AR3638	SE-Central	390 km/s	21/2100 UTC +/- 12 hours	Weak glancing impact
19/1300	Partial?	AR3637	SW-Central	Still	Under	Analysis

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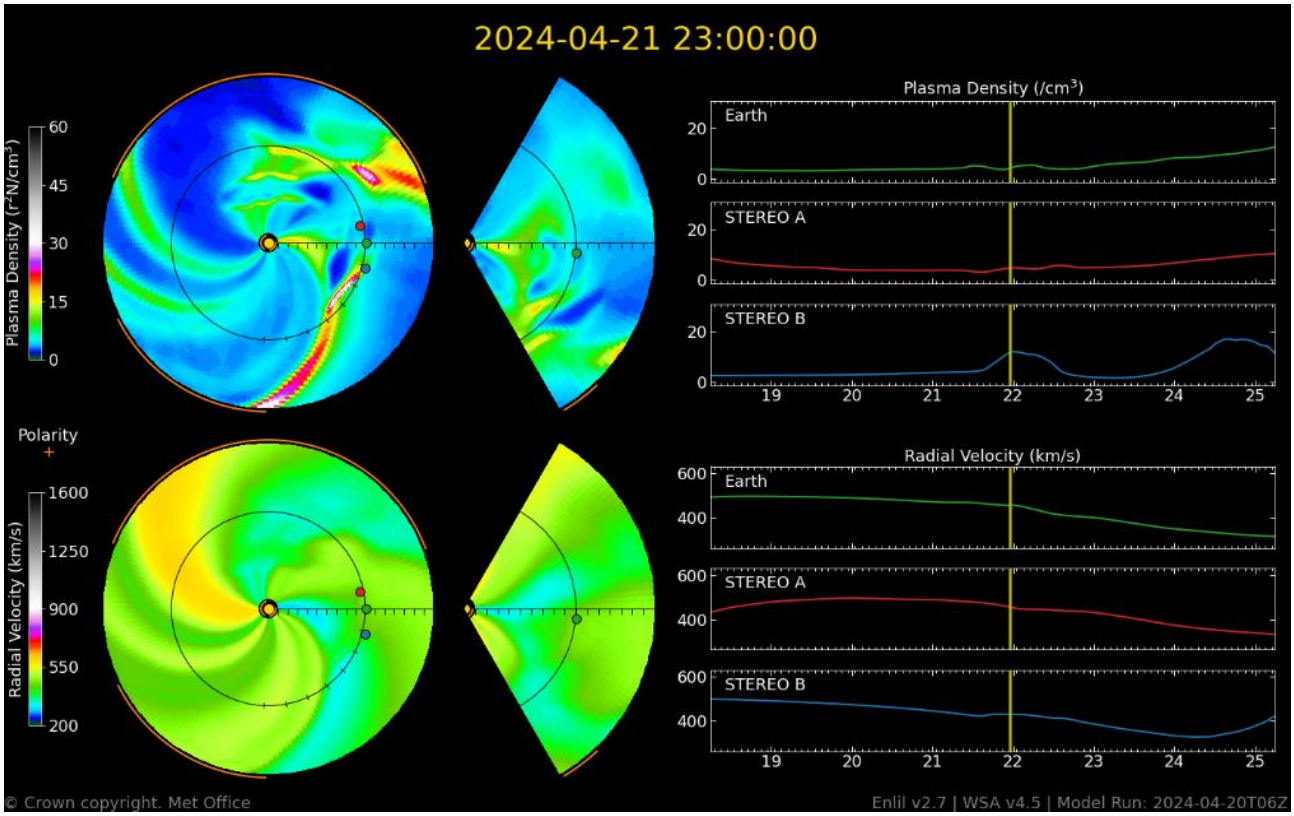
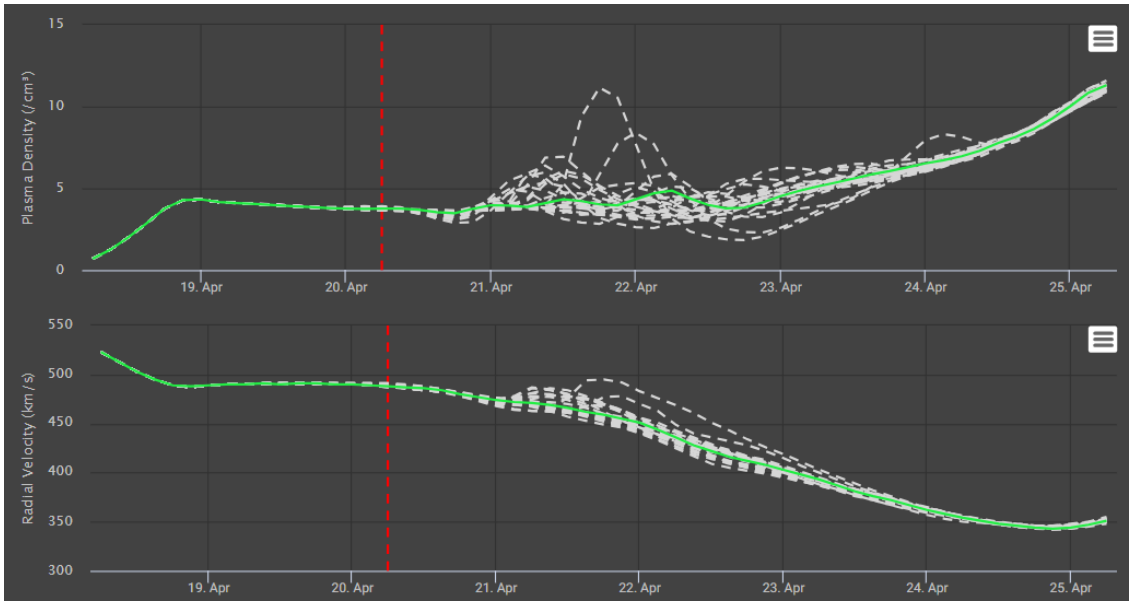
Figure 2: Enlil showing weak glancing impact late 21 Apr, with ensemble showing potential through the period. This doesn't include any potential CME from the 19 Apr M-flare.





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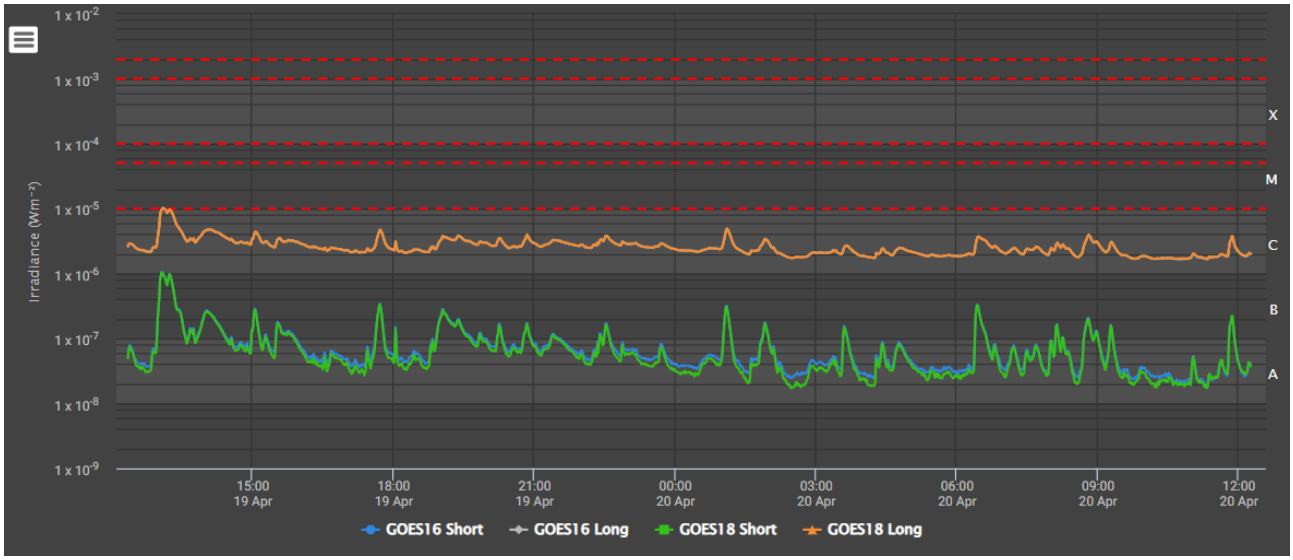
Radio Blackouts - X-Ray Flares:

Moderate activity is expected to continue with further occasional M-flares expected. There is a slight chance of X-class flares.

The main flare risk is from the southern central disc complex of sunspots, which is composed of a number of distinct regions, but with an overarching magnetic structure evident in SDO imagery (e.g. aia-171). The most complex of these regions are AR3645 and AR3647 due to their mixed polarity environment and signs of slow growth, while AR3643 continues to show some decay. Notable flare activity is also possible from recently re-emerged AR3637 and AR3638 to the southwest of this complex. There is one other large region on the disc, AR3639, however this maintains a simple bipolar configuration and remains stable with limited flare activity. The other regions on the disc are small and simple, with only limited flaring.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	Yes	75	75	75	75
Very Active	R3 to R5 X Class	No	15	15	15	15

Figure 3: GOES 16/18 X-ray flux



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux as observed by GOES-18 has persisted at background levels and is expected to generally remain so. There is a slight chance of the observed flux increasing in response to any notable flares, which slightly increases through the period as the large complex of sunspots in the southern centre disc traverses westwards.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux as observed by GOES-16 has persisted at background, with an enhanced solar wind environment due to recent CME arrival and coronal hole fast wind onset from CH25/-. This has likely increased flux at lower orbits, and as solar wind pressure eases days 2-3 (21-22 Apr) the observed flux at GEO is expected to increase from Background to Moderate, perhaps peaking High. This is only low confidence however due to the chance of glancing CME arrivals also during days 2-3, which would limit any likely increase in observed flux.

The associated fluence is expected to persist below the Active threshold, but with a slight chance of approaching this level later in the period, mainly if any potential CME arrivals miss, allowing the build-up of flux. This increase in flux is indicated by REFM, although this may be under-estimating the potential despite not taking account of any further CME arrivals.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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